

Stakeholder Engagement Report: Water Resources

Climate Change Preparedness in New Jersey

November 2013

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This report was prepared for the New Jersey Climate Adaptation Alliance which is facilitated by Rutgers University. The views and insights in this report do not reflect the position of Rutgers University nor the members of the Alliance Advisory Committee.

Background

This report is based on a series of meetings and surveys that involved a large number of individuals and organizations with some role in maintaining New Jersey's water resources. The purpose of these activities was to obtain input from stakeholders regarding perceptions of climate change impacts affecting the water resources sector, challenges and gaps hindering climate change preparedness, and to identify areas where state and local policy can support greater preparedness within the sector. This stakeholder input will inform the New Jersey Climate Adaptation Alliance's development of public policy recommendations that support climate adaptation activities in the state. Thanks to all participants for giving their time and effort. Thanks also to the staff of the Environmental Assessment and Communication Group at the Edward J. Bloustein School at Rutgers who helped prepare and implement the online surveys, to Karen Alexander for her consultation on the survey content, and to Jeanne Herb and Marjorie Kaplan for facilitating this project. Any misstatements of fact regarding the meetings or surveys are the responsibility of the author, who sincerely hopes that they are few and insignificant!

The Water Resources Sector in New Jersey

New Jersey is a water-rich state, at least most of the time. Sometimes there is too much water, leading to flooding, and droughts periodically plague the state. New Jersey's surface waters – stream, lakes and reservoirs – support aquatic ecosystems, public and private water uses, and estuarine systems that all depend on the flow of water. In natural systems of New Jersey, most of the annual surface water flow is derived from ground waters, which also provide critical flows to public and private wells. Ground waters capable of supporting economical supplies of water are called aquifers.

Most of New Jersey's population and businesses are served by public water supply, sewerage and stormwater systems, which ensure that healthful water is provided to customers, that the resulting wastewater is treated prior to discharge, and that the precipitation on developed lands is properly managed. Water supply and sewerage systems are subject to a range of state and federal regulations. Stormwater systems are used to manage runoff from developed lands in an acceptable manner. For all three utility categories, "public" refers to the population served rather than the ownership. Public community water supply systems serving large areas may be investor-owned companies, while others are government-owned utilities. Nearly all public sewerage systems are government-owned, with the exception of some small developments. Stormwater systems tend to be non-governmental within commercial properties, multi-family developments, and developments with homeowners associations; the remaining stormwater systems are "public" and generally owned by governments.

In addition to those who own and manage water utility systems (water supply, sewerage and stormwater), other stakeholders in the water resources field include environmental

organizations, especially the watershed associations, as well as those who are engaged in planning for sustainable communities, and major water user groups such as industry, agriculture and municipalities.

Approach

Communication with organizations, agencies and utilities within the water resources sector took place in the summer and fall of 2013. Three primary mechanisms were used to gather information: (1) discussions at meetings where the topic of climate change preparedness was either the sole agenda item or a major component of the meeting; (2) informal responses to survey questions distributed in hard copy to the participants of the Environmental Summit meeting; and (3) online surveys of water utility professionals with a more complete suite of questions. One online survey focused specifically on boards, managers and staff of, and consultants to, water utilities; this survey was provided in a long form for top management and other experts, and a short form for others. In addition, an online survey targeted at professional planners primarily focused on other adaptation issues but included specific questions related to water. The following table provides a listing of major sources of information used in this report:

Target	Method	Interests Involved
New Jersey Clean Water Council	Regular meeting (September): discussion	Statutory advisory body to NJDEP, diverse membership
New Jersey Water Supply Advisory Council	Regular meeting (August): discussion	Statutory advisory body to NJDEP, diverse membership
Environmental Organizations	Regular meeting of the Environmental Summit (August): discussion/survey	12 organizations attended
Smart Growth Organizations	Special meeting (September): discussion	New Jersey Future, PlanSmartNJ, Regional Plan Association
Watershed Organizations	Special meeting (September): discussion/short survey	6 organizations attended; organized by the Watershed Institute

Target	Method	Interests Involved
Water Utilities	Online survey (September/October) 3 separate Water Utilities online surveys administered. Responses as of November 1, 2013: NJUA (6 responses), Long Form (47 responses), Short Form (49 responses)	American Water Works Association-NJ Chapter, Association of Environmental Authorities, New Jersey Utilities Association, and New Jersey Water Environment Association
Professional Planners	Online survey (July): 137 respondents	NJ Chapter, American Planning Association
Delaware River Basin Commission	Meeting and summary of agency materials (June)	Agency staff

Online Surveys

A link to the online Water Utilities survey was provided to members of the American Water Works Association-NJ Chapter (AWWA-NJ), Association of Environmental Authorities (AEA), and New Jersey Water Environment Association (NJWEA) by email. Executive managers of utilities were encouraged to respond to a longer survey of 33 questions, while all others were encouraged to respond to a shorter survey of 15 questions. As of November 1, 2013, there were 49 responses to the short-form survey and 47 responses to the long-form survey.¹ In addition, a link to an online survey was provided via the New Jersey Utilities Association (NJUA) to previously identified representatives of seven investor-owned water utilities, six of whom responded²; this survey was essentially the same as the long-form survey provided to the other organizations. The details of the NJUA survey are addressed in the Utilities Sector report. For the purposes of this report, these 6 responses are incorporated with the 47 long-form survey responses for a total of 53 responses.

There were 137 responses to a survey administered through the American Planning Association's New Jersey chapter. The results are detailed in the Summary of Online Surveys report, but issues related to water resources are included in this report.

¹ All questions on the short-form survey are also contained in the long-form survey.

² All respondents to the NJUA version of the survey identified themselves as CEO, COO or Director.

The online surveys were provided to all members of various relevant professional organizations. Responses were provided by those who chose to participate, and were anonymous. Therefore, respondents may not be generally representative of their peers, as self-selection bias may exist. For example, it appears that planners whose service areas experienced damage during Hurricanes Irene and Sandy were disproportionately likely to participate. The survey responses from the AWWA-NJ, AEA, and NJWEA show a stronger response from government-owned utilities for wastewater than for water supply, with a good cross-section of functions (from Executive Directors to operations staff to consultants). Still, a disproportionate number of surveys indicated severe flooding from Hurricane Sandy in their service areas, revealing a possible self-selection bias toward coastal systems. On the other hand, representatives of six of the seven major investor-owned water utilities responded through the NJUA survey, on behalf of their corporations, indicating that those results are representative.

Delaware River Basin Commission

The Delaware River Basin Commission (DRBC) is an agency formed by compact legislation in 1961 and comprised of the states of Delaware, New Jersey, New York, and Pennsylvania, and the federal government. The DRBC has compact authority regarding the discharge of pollutants to the Delaware River and the withdrawal of water from the river; DRBC focuses primarily on depletive and consumptive uses (i.e., exports to other basins and evapotranspiration) in this role, as these uses are not returned to the river. The DRBC also plays a major role in efforts to reduce flood damages within the Basin, with the flood of 1955 being a major catalyst for formation of the agency. The DRBC's role in water withdrawals brings it into the process established by the 1954 U.S. Supreme Court decree and 1983 "Good Faith Agreement" by which New York City and the Basin states settled and periodically review the amount of Delaware River waters transferred out of the basin by NYC and New Jersey, and the timing and quantity of release flows from NYC's Delaware Basin reservoirs. These release flows maintain flows in the Delaware River itself, so that downstream water supplies for Philadelphia and other systems are protected from upstream migration of the saltwater front during droughts. The DRBC was included in the discussion and is highlighted in this report because it could have a significant role in climate change adaptation affecting New Jersey although it is neither a state nor a federal agency.

Summary

Perceptions of Climate Change Impacts in the Water Resources Sector

The survey responses from online Water Utilities surveys, the Planners survey, and the twelve organizations present at the Environmental Summit meeting showed general agreement that climate change is occurring and is a risk to New Jersey. They also show strong consensus that state and local officials do not understand the implications of global climate change for New Jersey, and most felt that the media likewise do not. While

respondents generally agreed that the international scientific community understands the science behind global climate change, support for this concept was less robust among the respondents of the water utilities survey. However, a strong consensus existed that it is possible for public policy makers and society to develop adaptations to climate change that will minimize adverse effects. For more detailed results of the surveys, please see Appendices D and E.

Climate Change Impacts of Greatest Concern

Watershed and Environmental Impacts

Watershed organizations anticipated climate change impacts to their local watersheds that varied based on location, primarily between the Coastal Plain watersheds of southern New Jersey and the Piedmont and Highlands watersheds of northern New Jersey. Flooding, drought effects on recharge and stream flow, and stream erosion were of concern in northern watersheds, while in southern watersheds the key issues included shoreline damages, increased aquifer demands and storm impacts. Invasive species concerns were common to both. Several broader issues were also raised, including whether inland watersheds would be subject to more development as coastal areas became more at risk from coastal flooding and storm surges, causing a displacement of development to interior areas.

A general theme that emerged from the watershed, smart growth, Water Supply Advisory Council (WSAC) and NJ Clean Water Council (NJCWC) meetings is that water resources impacts are not very clear yet, due to difficulties in projecting or ascribing large-scale trends to a local level. The smart growth organizations raised issues about major events that cause flooding and damage water infrastructure, long-term infrastructure stress and the potential for sea level rise to exacerbate saltwater intrusion in drinking water supplies. Watershed organizations shared these concerns and also raised issues of droughts, stormwater generation (from more severe storms) and related increases in Combined Sewer Overflows (CSOs), loss of wetland habitats due to sea level rise, harm to aquatic ecological integrity, and that climate change may exacerbate the impacts of development patterns on water resources.

The NJCWC and WSAC raised a variety of issues related to precipitation patterns, including uncertainties regarding trend shifts, effects of precipitation extremes (both droughts and floods) on utility operations, lengthening growing seasons that may increase both irrigation needs and evapotranspiration losses, and potential related losses of ground water recharge. Both councils noted the increased stresses on utilities and their finances and on regional resiliency. NJCWC members added issues of waterborne disease incidence (related to warmer waters) and a series of utility management issues including the need to modify existing regulatory standards to address climate change, the need to fully map infrastructure locations and yet keep this information secure, and a changing balance in the question of

centralization versus decentralization of both water and energy facilities. WSAC members pointed out that utility staff will need to increase technical competence to address changing and more complicated operations, including those resulting from source water quality changes due to temperature increases and biological impacts.

Fourteen individuals from twelve organizations provided responses to a short survey administered at the Environmental Summit meeting. Respondents were given a list of climate change impacts and asked to rate each as “great concern”, “some concern”, or “little concern.” The survey questions are included as Appendix F. The ratio of “great concern” responses to “some concern” or “little concern” responses can be used to identify impacts and issues of greatest concern. The highest ratios (3:1) were for higher water temperatures, reduced recharge of aquifers, and increased severity of coastal storm surges. Other major concerns include reduced water supply availability, increased severity of storms, increased tidal wetland erosion/loss, release of toxic materials from flooding of hazardous or contaminated sites, increased sanitary and combined sewer overflows, and physical damage to critical utility infrastructure (all 2.5:1).

Water Utility Interests and Infrastructure Impacts

Water utility professionals responding to the surveys showed considerable concern (greater than half of respondents indicating “great concern” or “some concern”) for a wide range of climate change impacts regarding water resources and water utilities (see Appendix D). However, the issues of greatest concern, as indicated by the ratio of “great concern” to “some concern” are increased severity of storms, increased severity of coastal storm surges, physical damage/ deterioration to critical utility infrastructure (energy, water, wastewater), increased occurrence / severity of coastal floods, increased frequency of severe storms, and more severe droughts.

The water utility professionals answering the long-form survey were asked to rank climate change impacts against other water utility challenges. Out of 38 respondents, "Climate Change Impacts" was in last place, just below "Meeting Customer Price/Rate Expectations." Asset management and regulatory compliance issues rank at the top. The highest priorities relate to a combination of immediate issues (regulations and budgets) and ensuring the structural integrity of utility systems (which will need eventually to address impacts of climate changes).

It is worth noting that professional planners, in their responses to a different mix of priorities deemed relevant to their work, ranked "Aging Infrastructure" highest, but ranked climate change second. Planners showed a very high level of concern with the ongoing function of various infrastructure systems. Among impacts presented in the Planners' survey, “Damage to critical utility infrastructure (electrical, water, wastewater)” had by far the highest ratio of “great concern” to “some concern” (nearly 4:1). The second highest ratio (over 2:1) was for “Disruptions to transportation system”, followed by “Decrease in function of water and

sewer systems” (from Sea Level Rise) and “Decrease in water supply” (from Heat and Drought), which each had ratios of nearly 2:1. These impacts clearly relate to concerns about flooding, stormwater runoff, sewage overflows and damage to infrastructure (including energy and water).

Perspectives on Relative Priorities

In meetings with the smart growth, watershed and Environmental Summit organizations, participants were asked to name climate change impacts that would be of equal or greater importance to New Jersey than issues related to water resources impacts. For this question, sea level rise was not considered a direct water resources impact, although it could in turn create water resources impacts such as saltwater intrusion to aquifers. In general, watershed organizations were least likely to suggest other, higher priorities, but some did suggest equal concern for air quality, ecosystem/habitat/species losses and shifts (including migration of related insect diseases), food security and lack of predictability. Environmental Summit participants also identified habitat/species changes as being of equal importance to water resources impacts. Other issues suggested as higher priority included sea level rise (physical impacts on land development), the effects of extreme temperatures on public health (especially in cities) and agricultural viability, economic impacts of adaptation, and transportation system variability.

The WSAC and NJCWC meetings addressed a related question, regarding what climate change impacts were of greatest important to water resources and water utilities. There was an emphasis on loss of electric power for utility operations, projected sea level rise and its effects on infrastructure, invasive species migration (which could affect reservoirs and water supply intakes), and the effects of higher peak temperatures on equipment. Notes from the Environmental Summit, NJCWC, and Smart Growth meetings are included as Appendices F, G, and H.

Hurricane Sandy Experiences

Smart growth organizations noted a recent Regional Plan Association poll suggesting that the public’s greatest concern is electricity system failures, which is not surprising given the extended outages from Hurricane Sandy. Other issues raised include communication failures and transportation system disruption. One point made is that distinctions must be made between acute impacts (events) and chronic impacts (trends).

Stakeholder Perceptions of Sectoral Preparedness

Level of Preparedness for Water Utilities

Environmental Summit participants raised a number of concerns regarding the preparedness of sewerage and stormwater utilities for storm impacts, and noted that water supply and wastewater utilities seemed to be overwhelmed keeping up with existing

infrastructure maintenance. What becomes clear from the surveys of water utility professionals is that from prior to Hurricane Irene to after Hurricane Sandy, the respondents believe their utilities have made significant strides in preparedness for major storms. Not all respondents answered the questions, but of the 86 that did, those indicating their utilities are now "extremely well prepared" has jumped from 11 to 26, and those indicating "somewhat prepared" dropped from 28 to 16. In both cases, however, the majority responded "adequately prepared" (at 42 prior to Irene and 44 after Sandy).

Utility survey respondents were also asked open-ended questions about what their utility needs to prepare for and respond to climate change impacts over the next two decades, and the biggest challenges they face in doing so. Needs ranged broadly from in-house and local (e.g., stand-by power with adequate fuel, emergency agreements for water from neighboring systems, training) to large-scale issues (e.g., risk assessment, clear guidelines on risk mitigation and infrastructure upgrades/hardening, financial aid to remove infrastructure from hazard areas, government policies and plans that can be incorporated into facility operations). The major challenges also ranged from in-house and local (e.g., access to facilities in hazard areas during storm events) to large-scale issues (e.g., regulatory hurdles, lack of risk assessment, uncertainty about future conditions). However, the dominant challenge raised is funding, competition for funding, and pressure against raising rates to levels that allow for effective asset management and risk management. Of 39 volunteered responses, 19 explicitly mention financing issues and several others raise issues that have funding implications.

Level of Preparedness for Watersheds

Watershed organizations clearly indicated that local government awareness of climate change impacts in their watersheds was low to very low, though with the recent storms municipalities and the public are beginning to pay some attention to the issues. Several organizations indicated that people are not recognizing that the environmental impacts of past development practices will get worse with climate change. At the state level, watershed organizations noted that some major state and regional management efforts (e.g., Highlands, Pinelands, NJDEP) have faced eroding funding, political support and overall capacity to address ongoing issues, much less climate change implications. However, NJDEP efforts in watershed management have been beneficial in some cases.

Leading Practices

Implicit in the survey and meeting responses are "best practices" that various interests have identified as high priorities for action. However, most of these practices are more generally associated with broader issues such as floodplain management and hazard mitigation, rather than climate change adaptation per se, though climate change may help inform these actions. Good examples of municipal efforts provided by watershed organizations primarily addressed general watershed or growth management issues of interest to municipalities,

not climate change specifically. Examples included a variety of ordinances for riparian areas, flood plains, etc.; land preservation; and recent work in the Maurice River areas to work with FEMA on potential impacts of sea level rise along the Delaware Bay shore.

Delaware River Basin Commission

The DRBC's role in flood damage reduction has facilitated a variety of flood control projects, mostly in Pennsylvania, that reduce flooding in the Pennsylvania tributaries and downstream areas of the Delaware River, including areas of New Jersey. More recently, the flood reduction and water supply roles have intersected through efforts to determine whether NYC reservoir management can provide flood control benefits.

The DRBC has been engaged with an extensive effort to determine the potential impacts of climate change regarding flooding, water supply needs, and estuarine impacts. Its 2060 Action Plan addresses these needs, among others. Some project reports have been released through the Delaware Estuary Partnership, with which DRBC is a partner agency. DRBC and USGS have partnered on a project (part of the National Water Census) to understand the impact of future water demands, future land uses and two climate change scenarios on stream flows, and the effects of these flows on water availability for both human and ecological needs. Of note, depletive and consumptive water uses have changed little since 1960. A significant question is whether these losses will remain stable or increase in response to climate change. DRBC is also very concerned about the impact of sea level rise and potential stream flow changes on the saltwater front in the Delaware River, and has partnered with the U.S. Army Corps of Engineers to create a detailed modeling approach to assess this concern.

In summary, DRBC is clearly well advanced into the "risk assessment" component of climate change adaptation, developing critical tools on several fronts that will allow for better projections of climate change impacts and better development of adaptive responses.

Perceived Challenges and Gaps in Preparedness

In both the meetings and surveys, respondents were asked to identify critical adaptation practices for which New Jersey has made least progress. The following were identified as major shortfalls or needs, with no ranking implied or attempted:

- Sewerage and stormwater system protection and management is insufficient regarding preparation for storm impacts
- Water supply and wastewater utilities in many cases are overwhelmed with costly infrastructure needs while facing intense pressures to keep rates down and (in the case of municipal utilities and municipal utility authorities) to contribute funds to their municipal government budgets.

- There is inadequate public notification and education regarding impacts such as storm discharges from CSOs, stormwater systems and WWTPs.
- There is a perceived need to change public behavior to adapt to climate change (versus assuming that the climate change impacts will be overcome without need for behavioral and development pattern changes).
- Climate change issues should be explicitly addressed in the State Development & Redevelopment Plan and the NJ Statewide Water Supply Plan, including the potential for saltwater intrusion related to sea level rise. Formal State acknowledgement of climate change as specific issue in general is perceived as a gap.
- Stormwater management practices need to shift to green infrastructure, in both development and redevelopment, along with modernization of civil engineering practices regarding climate change
- More funding is needed for Blue and Green Acres programs beyond what is currently allocated.
- There is a need for regulatory systems that fit together in a cohesive whole, especially for the coastal area, and for an increase in state government planning capacity generally.

In addition, the watershed and smart growth organizations and the Environmental Summit looked at the question of which practices and policies are clearly working against adaptation to climate change in the water resources fields. The following were identified as examples of “maladaptation” and other constraints regarding effective implementation of adaptation practices:

- Tendency of municipalities to focus on “hard engineering” approaches such as widening streams, structural flood control projects, larger culverts and bridges, road reconstruction
- Continued intense development near streams
- Development of solar energy arrays (for climate change mitigation) in the wrong locations, leading to more water resources problems
- National security issues make it hard to conduct a public vulnerability analysis and risk assessment on many types of infrastructure
- Residential Site Improvement Standards are based on old data and past trends, and so can encourage development practices (e.g., stormwater standards) that will be inadequate into the future, and may be inadequate now.
- The Municipal Land Use Law, Draft Strategic Plan, Wastewater Management Plans and Permit Extension Acts do not adequately acknowledge and effectively address these issues. Economic incentives for business also are not incorporating the implications of climate change.

- Agricultural water certification rules do not acknowledge and insufficiently address the coming conflict between greater irrigation needs and less water availability during droughts due to climate change.
- NJDEP regulations primarily address development impacts, but make it very difficult to implement environmental restoration projects that are not associated with development.
- The State’s campaign is focused on “Stronger the Storm” rather than developing a consensus vision of a better future; in other words, to “overcoming” the impacts of Hurricane Sandy, rather than responding to broader issues.

The major societal causes of inadequate progress were discussed by the smart growth organizations, and included:

- Insufficient risk awareness and willingness to invest in the future. It is hard for the public, politicians and the private sector to see what is needed.
- Lack of a coherent vision, and coherence in communication about the issue
- Political leadership to mold public opinion has not been evident. It is not clear what would create the necessary groundswell of public interest in action.
- The lack of funding is linked to the lack of leadership which is linked to short-sightedness. Lack of sustained interest leads to episodic funding, which is less efficient and effective.

A variety of reasons were suggested as to why these problems exist, including: insufficient comprehension, professional competence and funding; short-term thinking, and short-term memories and denial of possible future risks (“It won’t happen again/to me”). There was a general sense that planning isn’t “sexy” and requires people to look far into the future, which is difficult and not normal human behavior. There may be a feeling that we can’t afford it, or that the necessary changes are anti-business. However, electric utilities are preparing to make large investments in adaptation, in part because they have a pricing signal that promotes action, where investment is directly related to the rate-setting process.

Recommendations

Respondents in meetings and surveys provided recommendations on short, medium and long term steps that need to be taken to better prepare the sector for climate change impacts and identification of perceived time horizons. A wide variety of recommendations are listed in the table below by source of the recommendation, and strength of recommendation (Low, Medium, High) where surveys were used.

Regarding major needs for action at the state, regional or federal levels, the following topics were identified by the largest number of water utility professionals as "Very Important" or "Important" in the long-form survey (see Appendix E), in rank order:

- Improved planning, coordination, and communication across affected entities
- Resilient emergency communications infrastructure
- Clearly established emergency response lines of communication
- Critical infrastructure assessments
- Clear policy direction with supporting incentives to expedite hardening and resiliency
- Improved coordination between water utilities (mutual aid) and state resources
- Development of innovative funding strategies to implement adaptation measures

For the responding planners on a similar question, the largest number of respondents to indicate “High Need” for a water-related topic was for “Critical infrastructure assessments” (105 of 131, and a ratio of over 4:1 for High:Some Need). The question did not specify what kinds of infrastructure and therefore respondents may have had energy infrastructure in mind but also could have been concerned about water infrastructure. Another need with a high ratio (nearly 2:1) was for “Updated regulations or guidelines addressing floodplains.” Finally, in ranking climate change against other major concerns, respondents gave a plurality (45%) of the top rank votes to “Aging Infrastructure;” the same caveat applies regarding whether the respondents were addressing water infrastructure, other infrastructure types, or all categories.

Environmental organization respondents indicated that improved planning, coordination and communication, training local government officials as to the constraints regarding restoration, water supply planning and conservation programs, shoreline change data and projections, and upgraded or new regulations for infrastructure upgrades, floodplain delineations and hazard mitigation planning are high priorities.

The following table summarizes the results from both surveys (S) and meetings (M).

Recommendations	Utility Professionals (S)	NJ Clean Water Council (M)	Water Supply Advisory Council (M)	Environmental Summit (S,M)	Watershed Associations (M)	Smart Growth Organizations (M)	Planners (S)
Response Source (M=meeting; S=survey) Response (H and M based on survey questions with quantitative results. X based on meeting discussions. Where an item is blank, it was not raised in the relevant survey or meeting.)							
Local climate adaptation plans	H			H			
Hazard mitigation plans	H	X		H		X	
Emergency preparedness plans that incorporate climate changes and local capacities	M			H			

Recommendations	Utility Professionals (S)	NJ Clean Water Council (M)	Water Supply Advisory Council (M)	Environmental Summit (S,M)	Watershed Associations (M)	Smart Growth Organizations (M)	Planners (S)
Response Source (M=meeting; S=survey) Response (H and M based on survey questions with quantitative results. X based on meeting discussions. Where an item is blank, it was not raised in the relevant survey or meeting.)							
Vulnerability assessments/Census of vulnerable sub-populations	M			H		X	
Inclusion of vulnerable populations in emergency preparedness plans	M			H			
Risk maps (e.g., storm surge, sea level rise, inundation)	L		X	H		X	
Alternate service distribution routes (e.g., interconnections)	L			H			
Public awareness program on climate change impacts	H	X	X	H			
Public and employee awareness campaign on emergency preparedness	M			H			
“Excessive Heat” warning system	L			M			
Local electric utility communication plan for outages affecting water utilities	M			H			
Local water utility communication plan for outages	L			H			
Crisis and Emergency Response Risk Communication System	L			M			
Stockpiling of supplies (fuel, food, water, medicine)	M			H			
Green infrastructure (e.g. riparian buffers, living shorelines, native landscaping, tree planting, wetland restoration, porous pavement)	M			H			M
Capital improvement and maintenance plans which incorporate climate change	H	X		H		X	
Buyout of properties in high hazard floodplains	M			H			
Raising, relocating or flood-proofing capital facilities prone to flooding or storm surges	H			H			
Incentive programs to relocate development away from vulnerable areas	M	X		H			H

Recommendations Response Source (M=meeting; S=survey) Response (H and M based on survey questions with quantitative results. X based on meeting discussions. Where an item is blank, it was not raised in the relevant survey or meeting.)	Utility Professionals (S)	NJ Clean Water Council (M)	Water Supply Advisory Council (M)	Environmental Summit (S,M)	Watershed Associations (M)	Smart Growth Organizations (M)	Planners (S)
Socioeconomic vulnerability assessments	M			M			M
Regulatory programs to encourage the accelerated replacement of aging infrastructure	H			M		X	
Clear policy direction with supporting incentives to expedite hardening and resiliency measures	H			H			
Clearly established emergency response lines of communication	H			M			
Improved planning, coordination and communication across affected entities	H			H			H
Enhanced weather forecasting (short-term)	M			L			
Improved climate and weather modeling capacity for local scale assessments (long-term)	M			L			M
Critical infrastructure assessments	H		X	M			H
Improved coordination between water utilities (mutual aid) and state resources	H			H			
Improved coordination between water utilities and other sectors (health, planning, transportation, emergency planning)	M			H			
Strengthened employee training and retention for water utilities	M		X	M			
Rapid response system for extreme weather events	M			H			
Strengthened training of governing bodies for water utilities	M		X	M			
Resilient emergency communications infrastructure	H			M			
Development of innovative funding strategies to implement adaptation measures	H		X	M		X	M
Water supply planning and conservation	M			H			M
Shoreline change data and projections	M			H			M

Recommendations	Utility Professionals (S)	NJ Clean Water Council (M)	Water Supply Advisory Council (M)	Environmental Summit (S,M)	Watershed Associations (M)	Smart Growth Organizations (M)	Planners (S)
Response Source (M=meeting; S=survey) Response (H and M based on survey questions with quantitative results. X based on meeting discussions. Where an item is blank, it was not raised in the relevant survey or meeting.)							
Inland waterways flood hazard area delineation data and projections	M			H		X	
Assistance with stockpiling of supplies	M			L			
Updated or new regulations or guidelines on:							
Design and construction standards	H			H		X	M
Emergency planning	M			M			
Infrastructure upgrades	M			H			
Floodplain delineation revision	M	X		H		X	
Floodplain construction	M	X		M		X	M
Hazard mitigation planning	M			H		X	
Stormwater management		X		X			
NJ Statewide Water Supply Plan			X	X	X	X	
Improved technical training and support for water utilities from State universities and colleges			X				
Consistent set of climate change and precipitation scenarios, sanctioned by State agencies, for planning/design			X				
State guidelines for water utility resiliency improvements			X			X	
Improve wastewater beneficial reuse		X					
Decentralization of facilities to avoid large-scale service disruptions		X					
Statutory mandates to ensure adequate infrastructure		X					
Require municipal ordinances to address climate change risks		X					
Agriculture methods that improve viability in stressed weather conditions				X			
Protection of water supply source areas and delivery systems				X			

Recommendations	Utility Professionals (S)	NJ Clean Water Council (M)	Water Supply Advisory Council (M)	Environmental Summit (S,M)	Watershed Associations (M)	Smart Growth Organizations (M)	Planners (S)
Response Source (M=meeting; S=survey) Response (H and M based on survey questions with quantitative results. X based on meeting discussions. Where an item is blank, it was not raised in the relevant survey or meeting.)							
Restoration of past ecological damage to improve resiliency				X			
Urban flood damage mitigation				X			

Resources Needed for Adaptation

Water utility professionals emphasized through both specific survey responses and open-ended questions that pressures on utility finances are a major threat to the ongoing capacity of utilities to maintain their existing systems, much less address climate change adaptation needs. While it is obvious that funding is necessary for action, less obvious is what is necessary to achieve the funding. Nationally and in New Jersey, most utility costs are covered by ratepayers, with limited assistance from the tax codes (directly for investor-owned utilities and indirectly for government-owned utilities³) and the NJ Environmental Infrastructure Financing Program. Utility rates are driven by a combination of service needs and regulatory requirements, and are subject to review by the Board of Public Utilities (detailed, for investor-owned utilities) and by the Local Government Review Board (generally more focused on bonding capacity, for government-owned utilities). Therefore, providing the necessary revenue for proper asset management and climate change adaptation will require a combination of regulatory requirements (to both drive and support utility action) and regulatory acceptance (to allow effective action and appropriate rates). To achieve these regulatory adaptations will in turn require political will that accepts costs as a necessary basis for action.

Watershed associations identified several areas where resources (beyond practices and policies addressed above) are needed to improve adaptation, including: financial assistance for riparian area protection, wetlands restoration, etc.; protocols for post-storm responses to environmental ecological damages, such as trees in streams, new openings in dense forests, etc.; methods that provide a sense of accuracy regarding restoration/mitigation project impacts; and standards for project planning.

³ Revenue bonds from government utilities provide tax advantages to buyers, which affect the bond costs.

Insights from the Author

Recommended High-Priority, Short-Term Policy Initiatives

Based on the meeting discussions and surveys, the following state and local policy initiatives appear to be the most important over the upcoming 12 months to significantly increase climate change preparedness within the water resources sector.

1. **Risk assessment and mapping** that incorporates the effects of climate change, beginning with sea level rise as the issue with the best quantitative forecasts to date. Given that FEMA flood plain mapping does not include the impacts of Hurricane Irene, much less Hurricane Sandy, there is a significant risk that redevelopment from Sandy will lock major future risks in place due to outdated mapping.
2. Explicit criteria for **modification of water infrastructure** to address climate change impacts. Utilities executives need specific guidance that will help them make the case for action with those who control utility finances. The actual modifications will occur over decades, but major expenditures are being planned now due to Hurricane Sandy and need better guidance.
3. **Modified water utility regulations** that require, and facilitate funding for, asset management and climate change adaptation activities. The existing system, especially for government-owned utilities, creates a perverse incentive to disinvest in utility assets, which reduces rates in the short term but inevitably increases them more in the long term.
4. Improved and greatly increased **programs to relocate development** outside of hazard areas, and to reduce risks to those land uses that must remain. Fiscal pressures at the federal and state levels are decreasing the sustainability of repetitive repairs and replacements of damaged properties. It is better to relocate assets now, rather than after the next storm when federal support may be less available.
5. **Improved emergency preparedness** for water utilities and other infrastructure that will both minimize the impacts of severe weather events and improve responsiveness to damages that do occur. Emergency preparedness involves both planning and investments, from communications technology to infrastructure "hardening" and relocation.

Recommended Priority Long-Term Policy Initiatives

Other policy initiatives that would greatly increase climate change preparedness within the water resources sector over a longer period include:

1. Establishment of **regulatory climate change scenarios** as the basis for state, local and utility planning, incorporating the sea level rise projections noted above, but also including new "design storm" graphs, methods for projecting future precipitation patterns, modified "drought of record" conditions, etc., as the best estimate of

possible future conditions. The scenarios would be used to test regulatory and project proposals to ensure that the proposals address the specific set of climate change impacts envisioned by the scenarios. All players need specific targets to use in their planning and design work.

2. Development, adoption and implementation of **Hazard Mitigation Plans** that explicitly incorporate climate change adaptation needs, including the needs of vulnerable populations. These plans need to be as much focused on risk mitigation as on emergency response, so that emergency response resources are not overwhelmed when emergencies do occur.
3. Long term **public education campaigns** that reinforce awareness of, and improve support for, necessary actions related to climate change adaptation and water utility resilience. There are many issues that attract (or distract) public attention; as storms recede in memory, a strong need will exist to continue making the connection between risk, policy and action.
4. Proposal and **adoption of state planning documents** and policies that provide a basis for future actions. The State Development and Redevelopment Plan, the NJ Statewide Water Supply Plan and other documents are necessary foundations for a variety of state programs.
5. Development and implementation of **new approaches to the form and function of urban areas**, so that they provide strong economic, community and environmental benefits with less risk of harm from severe weather events and other climate change impacts. Our cities are almost all on coastal and estuarine water bodies, at risk from storm surge and flooding. They need new approaches to redevelopment and retrofitting that will mitigate risks while improving urban amenities including, somewhat ironically, their proximity to water.

Conclusion

The meeting discussions and surveys make very clear that it is extremely difficult to separate climate change impacts on water resources and water utilities from the ongoing challenges the utility sector already faces. If our current approaches to water resources, watershed and water utility management were far more robust, it would be relatively simple to incorporate climate change adaptation as a needed facet of a well-designed program. However, New Jersey faces major disinvestment in its water utilities, extensive problems and challenges regarding water quality and watershed integrity (including and perhaps especially in our urban areas), and constraints on our water supplies. As such, climate change adaptation must be carefully integrated with efforts to improve our existing programs and facilities so that adaptation adds to the benefits, rather than being the proverbial straw that breaks the camel's back. Doing so will require careful analysis and planning, extensive coordination and interaction, and a level of political will toward improved management that has been missing for too long.

Appendices

Appendix A: Email to Water Utility Professionals

NJCAA Survey for Water Supply and Wastewater Professionals

Your help is needed! Please act by October 11! (Note: the survey deadline was extended to November 1.)

The New Jersey Climate Adaptation Alliance (NJCAA) has joined with the Association of Environmental Authorities, the NJ Section of the American Water Works Association, and the NJ Water Environmental Association to survey their members regarding climate change and asset management issues for public water supply and wastewater utilities. The survey is applicable to utilities owned by governments and government agencies, investor-owned companies, private companies or individuals, and also to non-utility professionals who routinely work in the water infrastructure field. For background on NJCAA, based at Rutgers University, please see their web site at <http://njadapt.rutgers.edu/> and the white papers on water resources and other impacts at <http://njadapt.rutgers.edu/climate-impacts-in-new-jersey>.

NJCAA's intent is to assess current thinking regarding these issues among water infrastructure professionals. The results will be used in a white paper to the NJCAA Advisory Committee on potential impacts and implications of climate change on a wide range of water resources.

The linked surveys are the same for all three organizations – please only respond once even though you may receive multiple notices asking for your views. **Survey responses are entirely anonymous.** NJCAA has provided the survey in two formats:

- **Full Version** (30+ minutes): This version is specifically for anyone who is a Utility Board Member, Elected Official with water utility oversight responsibilities, Utility Executive Director/CEO/COO, or other Utility Director or Manager. However, anyone with considerable expertise in utility management is welcome to take this survey. Please click on the following URL or paste it to your web browser: {Link deleted}
- **Short Version** (10-15 minutes): This version is for anyone else. Please click on the following URL or paste it to your web browser: {Link deleted}

Questions regarding this survey may be sent to the Water Resources Intermediary for this project:

Daniel J. Van Abs, PhD, PP/AICP
Associate Research Professor
Department of Human Ecology
School of Environmental & Biological Sciences
Rutgers-The State University of New Jersey
55 Dudley Road, New Brunswick, NJ 08903
vanabs@sebs.rutgers.edu
<http://humanecology.rutgers.edu/faculty.asp?fid=101>

Appendix B: Water Utility Professionals Survey Questions: Long Form

Preparing for Climate Change Impacts in New Jersey: Water Utilities_Long Version

Q1 Please read the following information and sign electronically in the box below, indicating your informed consent. Thank you for agreeing to participate in this online survey. This research is being conducted by Rutgers University in conjunction with the New Jersey Climate Adaptation Alliance. All members of the Association of Environmental Authorities, the NJ Section of the American Water Works Association, and the NJ Water Environmental Association are being asked to participate. Please only complete the survey once, even if you belong to more than one organization. The purpose of the survey is to obtain data to assess New Jersey's most pressing concerns resulting from climate change, and to help to prioritize a set of program, planning and policy adaptations that are necessary to prepare for and mitigate these impacts. There are no reasonable or discernible risks to your participation in this study. We are not asking for your name on the survey, and will only utilize information collected in summary form to categorize or further explain important differences. If we are able to deduce your identity, the research will be confidential. Confidential means that the research records will include some information about you and this information will be stored in such a manner that there is some linkage between your identity (as deduced but not specified) and the response in the research. The information collected about you includes your opinions about climate change risks, ratings of concern about climate change impacts and your assessment of the needs for various climate adaptation programs. Please note that we will keep this information confidential by not including your name in the data records, limiting individual access to the research data and keeping it in a secure location. The research team and the Institutional Review Board (a committee that reviews research studies in order to protect research participants) at Rutgers are the only parties that will be allowed to see the data, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated. All study data will be kept for three years. The benefits of completing the survey are that you will contribute to further knowledge and insight about impacts to New Jersey from climate change and help to inform the development and prioritization of resources needed to support new or expanded programs or policies to address these impacts. The survey may require 30 minutes or so, for 33 questions. We strongly urge people taking this version to at least complete the 19 questions in the first two sections ("General Information" and "Climate Change and Utilities") but encourage you to also complete the final two sections ("Asset Management" and "Financial Impacts of Climate Change"). If you do not have time in one sitting to complete the survey, you may leave it open on your computer and then pick up where you left off. Participation is completely voluntary and refusal to participate will result in no penalties. You may opt out of completion of the survey at any time while taking it. If you have questions related to the research, please contact Jeanne Herb, Associate Director of the Environmental Analysis and Communication group, 33 Livingston Ave., New Brunswick,

NJ 08901, 848-932-2725, jherb@ejb.rutgers.edu. If you have questions about your rights as a research subject, you may contact the IRB Administrator at Rutgers University at: Rutgers University Institutional Review Board for the Protection of Human Subjects Office of Research and Sponsored Programs 3 Rutgers Plaza New Brunswick, NJ08901-8559 Tel: 838 932 0150 Email: humansubjects@orsp.rutgers.edu

- I have read and understand the risks and benefits of this research and agree to participate by typing my initials in this box. _____

Q32 Note: Where the term “water utility” is used in this survey, it refers to both water supply and wastewater utilities. GENERAL INFORMATION 1. Please indicate the organization that emailed you the link to this survey.

- American Water Works Association - NJ Chapter
- Association of Environmental Authorities
- NJ Water Environment Association

Q2 2. Please indicate the primary sector(s) in which you work:

- Public Community Water Supply System (publicly-owned)
- Public Non-Community or Non-Public Water Supply System (all ownership categories)
- Public/Domestic Wastewater Utility (publicly owned)
- Investor-owned Public Community Water Supply System
- Investor-owned Public/Domestic Wastewater Utility
- Other Private Sector (e.g. Industry) Water Supply/Wastewater
- Municipal Government
- County Government
- State Government
- Federal Government
- Consultant
- Contractor
- Equipment Manufacturer or Supplier
- Nonprofit
- Academic
- Other _____

Q3 3. In what aspects of water utility functions do you typically work? Select all that apply:

- Elected Official with water utility oversight and/or Non-Executive Water Utility Board Member
- Executive Management (CEO/COO or similar)
- Operations Management
- Treatment Operations
- Pipelines and Pumping Station Operations
- Administrative Support
- Rates / Regulatory Affairs
- Legal
- Engineering
- Planning
- Finance / Accounting
- Construction Management
- Public Policy / Government Affairs
- Emergency Preparedness
- Construction, Equipment Supply
- Other _____
- Not Applicable (don't work for or with water utilities)

Q26 4. What is your position?

- Non-Executive Board Member
- Elected Official with water utility oversight responsibilities
- Utility Executive Director/CEO/COO
- Utility Manager (other than Executive Director/CEO/COO)
- Utility Supervisor
- Utility Technical Staff
- Utility Non-technical Staff
- Consultant or Attorney (not on utility staff)
- Researcher and/or Academia
- Other _____

Q5 5. How long have you been in this position?

- 1 - 5 years
- 6 - 10 years
- 11 - 20 years
- More than 20 years

Q34 6. How long has your organization (or its predecessor) provided service in New Jersey?

- More than 100 years
- 50 - 100 years
- 25 - 50 years
- Less than 25 years

Q33 7. Primary type of community served by your Water Supply or Wastewater utility:

- Rural
- Suburban
- Urban
- Mixed (two or more of the above)
- Not Applicable (not associated with a water utility)

Q6 8. Do you live in New Jersey?

- Yes
- No

Q5 CLIMATE CHANGE AND WATER UTILITIES 9. Do you Strongly Agree, Agree, Disagree or Strongly Disagree (or Don't Know) with the following statements?

	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know
Global climate change is not occurring.	<input type="radio"/>				
Global climate change is mostly caused by human activity.	<input type="radio"/>				
Global climate change is primarily a natural phenomenon that occurs cyclically.	<input type="radio"/>				
Global climate change is a risk to New Jersey.	<input type="radio"/>				
Global climate change is a risk to me, my family, and my friends.	<input type="radio"/>				
The	<input type="radio"/>				

<p>international scientific community understands the science behind global climate change.</p>					
<p>I trust the scientific community to truthfully report their findings related to climate change.</p>	○	○	○	○	○
<p>Our state and local officials understand the implications of global climate change for my service area.</p>	○	○	○	○	○
<p>Our state and local officials understand the implications of global climate change for my industry sector.</p>	○	○	○	○	○

<p>The media I rely on communicate honestly with us about global climate change.</p>	○	○	○	○	○
<p>It is possible for public policymakers to develop adaptations to climate change to minimize adverse effects.</p>	○	○	○	○	○
<p>It is possible for water and wastewater utilities to develop adaptations to climate change to minimize adverse effects.</p>	○	○	○	○	○

Q6 10. Please rate how concerned you are about the following potential direct and indirect climate change related impacts to the ability of your water utility (if you are associated with a water utility) in your service area or to water utilities in general (if you are not associated with a water utility) to provide service:

	Great Concern	Some Concern	Little Concern	No Concern	Not applicable
Higher average ambient air temperature	<input type="radio"/>				
Increased algal blooms / eutrophication	<input type="radio"/>				
Increased concentration of water pollutants	<input type="radio"/>				
Reduced water flows in streams and lakes	<input type="radio"/>				
Reduced recharge of aquifers	<input type="radio"/>				
More severe droughts	<input type="radio"/>				
Salt water intrusion	<input type="radio"/>				
Increased annual water demand	<input type="radio"/>				
Increased summer season water	<input type="radio"/>				

demand					
Decreased annual water demand	<input type="radio"/>				
Increased frequency of severe storms	<input type="radio"/>				
Increased severity of storms	<input type="radio"/>				
Increased stormwater flows	<input type="radio"/>				
Increased occurrence / severity of coastal floods	<input type="radio"/>				
Increased severity of coastal storm surges	<input type="radio"/>				
Increased occurrence / severity of river floods	<input type="radio"/>				
Increased inundation of low-lying infrastructure (roads, pumping stations, electrical utility)	<input type="radio"/>				

substations, etc.)					
Release of toxic materials from flooding of hazardous or contaminated sites	<input type="radio"/>				
Increased heat stress/stroke (for field workers)	<input type="radio"/>				
Worker health and safety during major events	<input type="radio"/>				
Increased sanitary sewer overflows (SSOs)	<input type="radio"/>				
Increased combined sewer overflows (CSOs)	<input type="radio"/>				
Increased infiltration and inflow (I&I)	<input type="radio"/>				
Physical damage/ deterioration to critical	<input type="radio"/>				

utility infrastructure (energy, water, wastewater)					
Decrease in effectiveness of water supply and sewage treatment systems	<input type="radio"/>				
Increase in severity and length of unplanned service interruptions	<input type="radio"/>				
Other	<input type="radio"/>				

Q24 11. Was the service area of your water utility harmed by Hurricane Irene (2011)?

- Yes
- No

Q11 12. If so, in what ways? Select all that apply:

- Deaths (Customer/General Public)
- Deaths (Employee/Contractor)
- Injuries caused by event or response
- Short-term power loss (48 hours or less)
- Longer-term power loss (more than 48 hours)
- Short-term water supply loss (48 hours or less)
- Longer-term water supply loss (more than 48 hours)
- Short-term sewer service loss (48 hours or less)
- Longer-term sewer service loss (more than 48 hours)
- Severe flooding
- Minor flooding
- Major property damage (customers/community)
- Minor property damage (customers/community)
- Major property damage (my organization)
- Minor property damage (my organization)
- Road closures
- Resident evacuation
- Business closures
- Other _____

Q12 13. Was the service area of your water utility harmed by Hurricane Sandy (2012)?

- Yes
- No

Q13 14. If so, in what ways? Select all that apply:

- Deaths (Customer/General Public)
- Deaths (Employee/Contractor)
- Injuries caused by event or response
- Short-term power loss (48 hours or less)
- Longer-term power loss (more than 48 hours)
- Short-term water supply loss (48 hours or less)
- Longer-term water supply loss (more than 48 hours)
- Short-term sewer service loss (48 hours or less)
- Longer-term sewer service loss (more than 48 hours)
- Severe flooding
- Minor flooding
- Major property damage (customers/community)
- Minor property damage (customers/community)
- Major property damage (my organization)
- Minor property damage (my organization)
- Road closures
- Resident evacuation
- Business closures
- Other _____

Q28 15. Of the following climate change adaptations, which are in place, planned, or needed for communities within the service area of your water utility?

	In Place	Planned	Not Planned but Needed	Not Needed	Don't Know	Not Applicable
Local climate adaptation plans	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hazard mitigation plans	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Emergency preparedness plans that incorporate climate changes and local capacities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vulnerability assessments/Census	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

of vulnerable sub-populations						
Inclusion of vulnerable populations in emergency preparedness plans	<input type="radio"/>					
Risk maps (e.g. storm surge, inundation)	<input type="radio"/>					
Alternate service distribution routes (e.g. interconnections)	<input type="radio"/>					
Public awareness program on climate change impacts	<input type="radio"/>					
Public and employee awareness campaign on emergency preparedness	<input type="radio"/>					
"Excessive Heat" warning system	<input type="radio"/>					
Local electric utility communication plan for outages affecting water utilities	<input type="radio"/>					
Local water utility communication	<input type="radio"/>					

plan for outages						
Crisis and Emergency Response Risk Communication system	<input type="radio"/>					
Stockpiling of supplies (fuel, food, water, medicine)	<input type="radio"/>					
Green infrastructure (e.g. riparian buffers, living shorelines, native landscaping, tree planting, wetland restoration)	<input type="radio"/>					
Capital improvement and maintenance plans which incorporate climate change	<input type="radio"/>					
Buyout of properties in high hazard floodplains	<input type="radio"/>					
Raising, relocating, or flood-proofing capital facilities prone to flooding or storm surges	<input type="radio"/>					
Other	<input type="radio"/>					

Q15 16. What are the most important actions/programs needed at the regional, statewide or national level (both governmental and non-governmental) to support water utility efforts to prepare and respond to climate change impacts?

	Very Important	Important	Somewhat Important	Not Important	Don't Know
Incentive programs to relocate development away from vulnerable areas	<input type="radio"/>				
Socioeconomic vulnerability assessments	<input type="radio"/>				
Regulatory programs to encourage the accelerated replacement of aging infrastructure	<input type="radio"/>				
Clear policy direction with supporting incentives to expedite hardening and resiliency measures	<input type="radio"/>				
Clearly established emergency response lines of communication	<input type="radio"/>				
Improved	<input type="radio"/>				

<p>planning, coordination, and communication across affected entities</p> <p>Enhanced weather forecasting (short-term)</p> <p>Improved climate and weather modeling capacity for local scale assessments (long-term)</p> <p>Critical infrastructure assessments</p> <p>Improved coordination between water utilities (mutual aid) and state resources</p> <p>Improved coordination between water utilities and other sectors (health, planning, transportation, emergency)</p>	<input type="radio"/>				
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planning)					
Strengthened employee training and retention for water utilities	<input type="radio"/>				
Rapid response system for extreme weather events	<input type="radio"/>				
Strengthened training of governing bodies for water utilities	<input type="radio"/>				
Resilient emergency communications infrastructure	<input type="radio"/>				
Development of innovative funding strategies to implement adaptation measures	<input type="radio"/>				
Water supply planning and conservation	<input type="radio"/>				
Shoreline change data and projections	<input type="radio"/>				
Inland waterways	<input type="radio"/>				

flood hazard delineation data and projections					
Assistance with stockpiling of supplies	<input type="radio"/>				
Updated regulations or guidelines addressing design and construction standards	<input type="radio"/>				
Updated or new regulations addressing emergency planning	<input type="radio"/>				
Updated or new regulations addressing infrastructure upgrades	<input type="radio"/>				
Updated or new regulations addressing floodplain delineation revision	<input type="radio"/>				
Updated or new regulations addressing floodplain construction	<input type="radio"/>				
Updated or new	<input type="radio"/>				

regulations addressing hazard mitigation planning					
Other	<input type="radio"/>				

Q29 17. What does your organization most need to prepare for and be ready to respond to climate change impacts over the coming decades?

Q17 18. What are the biggest challenges to achieving water utility preparedness for climate change?

Q18 19. Please rank climate change impacts in importance relative to these other water utility challenges. (Drag and drop to rank 1 to 6 with 1 being most important and 6 being least important):

- _____ Regulatory Compliance
- _____ Achieving Revenue/Budget Targets
- _____ Asset Management
- _____ Meeting Customer Price/Rate Expectations
- _____ Employee Capabilities and Retention
- _____ Climate Change Impacts

Q35 20. Please rate your organization's preparedness:

	Not at all prepared	Somewhat prepared	Adequately prepared	Extremely well-prepared	Don't know
The preparedness of your organization for a major storm event prior to Hurricane Irene	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The preparedness of your organization for a major storm event post Hurricane Sandy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q36 ASSET MANAGEMENT FOR WATER UTILITIES 21. USEPA and others have recommended that water utilities (water supply and wastewater) prepare and implement long-term asset management plans. Which choice below represents your opinion of the long-term sustainability of an asset management program for water utilities?

- Only a buzz word or temporary fad, unlikely to be a sustainable program
- Likely to be implemented voluntarily by most systems as a standard business practice
- Likely to be implemented ad hoc rather than system-wide within individual utilities
- Likely to be mandated through State funding requirements or regulations
- Don't know/No opinion

Q37 22. Should public assistance to water utilities (e.g., NJ Environmental Infrastructure Financing Program loans) be dependent upon a demonstration that the water utility has effective system management such as asset management, with sufficient user rates to support asset management implementation? Which of the choices below best describes your opinion of this approach?

- Not necessary and will not guarantee efficient use of funding
- Necessary, but stringency should vary with size of utility
- Asset management is necessary for all systems and would help government agencies distribute funding efficiently
- Don't know/No opinion

Q38 23. Should NJPDES permits for sewer utilities be dependent upon a demonstration that the utility has effective system management such as asset management, with sufficient user rates to support asset management implementation? Which of the choices below best describes your opinion of this approach?

- Not necessary and will not guarantee proper asset management
- Necessary, but stringency should vary with size of utility
- Asset management is necessary for all systems
- Don't know/No opinion

Q39 24. Should water allocation permits for public water supply utilities be dependent upon a demonstration that the utility has effective system management such as asset management, with sufficient user rates to support asset management implementation? Which of the choices below best describes your opinion of this approach?

- Not necessary and will not guarantee proper asset management
- Necessary, but stringency should vary with size of utility
- Asset management is necessary for all systems
- Don't know/No opinion

Q40 25. Which choice below best represents the current level of asset management implementation in the water utility which with you are most closely associated?

- None
- Minimal (some implementation regarding tracking and assessing assets)
- Partial (implemented some specific asset management tools for managing risk and reducing lifecycle costs, and are developing an asset management plan)
- Significant (developed an asset management plan and initiated substantive implementation)
- Full (fully implemented a long-term asset management plan)
- Don't Know/No opinion

Q41 26. Which of the following software packages are being used to track assets by the water utility which with you are most closely associated? Select all that apply:

- Database or spreadsheet
- CMMS (Computerized Maintenance Management System)
- GIS (Geographic Information System: digital mapping associated with system information)
- FMS (Financial Management System)
- USEPA CUPPS (Check Up Program for Small Systems)
- Custom-designed Asset Management Program
- Other _____
- Don't Know

Q42 27. Rate the value of asset management programs for water utilities:

	Adversely	Somewhat Adversely	Neutral	Somewhat Beneficial	Dramatically Beneficial	Don't know
Improve internal coordination, communications	<input type="radio"/>	<input type="radio"/>				

and operation of the utility						
Assist with knowledge retention and information transfer within the utility	<input type="radio"/>					
Prolong asset life and value	<input type="radio"/>					
Assist with managing risk	<input type="radio"/>					
Improve regulatory compliance	<input type="radio"/>					
Improve security and safety of assets, employees and the general public	<input type="radio"/>					
Reduce disruptions to service and protect against business risk exposure	<input type="radio"/>					
Assist with decision making approaches for capital improvements	<input type="radio"/>					
Reduce operating and	<input type="radio"/>					

maintenance costs						
Reduce long-term capital expenditures	<input type="radio"/>					
Assist with public confidence and developing justifiable rates	<input type="radio"/>					
Improve the utility's bond rating and lower interest rates	<input type="radio"/>					
Lower utility insurance premiums	<input type="radio"/>					
Improve rankings for funding for grants and low interest loans	<input type="radio"/>					

Q43 28. Electricity costs constitute the following percentage of total operations costs for the water utility with which you are most closely associated:

- Less than 5%
- 5 - 10%
- 10 - 15%
- 15 - 20%
- 20% or greater
- Don't know

Q44 29. Rate the extent to which the reliability of electrical supply has a major influence on capital project decisions for the water utility with which you are most closely associated (1 being little to no effect and 5 being very significant effect).

	1	2	3	4	5	Don't know
Importance of electrical supply on capital project decisions	<input type="radio"/>					

Q45 30. Which of the following actions or techniques are being used to manage electricity demand by the water utility with which you are most closely associated? Select all that apply:

- Energy audits for buildings
- Building upgrades for energy conservation
- Energy audits for pumping facilities not associated with treatment works
- Energy audits for treatment works
- Replacement of existing capital equipment with energy-efficient equipment
- Installation of solar energy systems
- Installation of wind energy systems
- Installation of energy production systems using sludge or biosolids
- Third-party contracts for installation of energy conservation or production systems
- Installation or expansion of auxiliary generators
- Installation or expansion of fuel storage
- Agreements or contracts for emergency generators
- Agreements or contracts for emergency fuel
- Other _____
- None
- Don't know

Q46 31. Which, if any, of the following measures has your organization employed that reduce its contribution to greenhouse gas emissions:

- Installation of solar or wind energy systems
- Energy conservation measures
- Water conservation measures
- Fuel switching (e.g., oil or propane to natural gas)
- Building modifications for energy efficiency
- Use of electric fleet vehicles
- Use of natural gas/CNG powered fleet vehicles
- Water leak measurement and prevention
- Offering of customer-oriented conservation measures
- None
- Don't know

Q47 FINANCIAL IMPACTS OF CLIMATE CHANGE 32. Please respond to the following two statements:

	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know
My organization quantifies and separately identifies expenses related to climate change impacts and/or adaptations	<input type="radio"/>				
If it does not now do so, in the future my organization should quantify and separately identify expenses related to climate change impacts and/or adaptations	<input type="radio"/>				

Q48 33. Considering all of the major storm events that affected its operations in the past three years including Hurricane Irene, the Halloween snow storm, and Superstorm Sandy, and irrespective of whether your company attributes these events to climate change, in the aggregate,

the water utility with which you are most closely associated spent approximately how much to restore service and improve your system to be more resilient to such events (include all costs):

- More than \$100 million
- \$50 - 100 million
- \$25 - 50 million
- \$10 - 25 million
- \$1 - 10 million
- Less than \$1 million
- Don't know

Q49 Click the forward arrow below to submit. Thank you for taking this survey!

Appendix C: Water Utility Professionals Survey Questions: Short Form

Preparing for Climate Change Impacts in New Jersey: Water Utilities_Short Version

Q1 Please read the following information and sign electronically in the box below, indicating your informed consent. Thank you for agreeing to participate in this online survey. This research is being conducted by Rutgers University in conjunction with the New Jersey Climate Adaptation Alliance. All members of the Association of Environmental Authorities, the NJ Section of the American Water Works Association, and the NJ Water Environmental Association are being asked to participate. Please only complete the survey once, even if you belong to more than one organization. The purpose of the survey is to obtain data to assess New Jersey's most pressing concerns resulting from climate change, and to help to prioritize a set of program, planning and policy adaptations that are necessary to prepare for and mitigate these impacts. There are no reasonable or discernible risks to your participation in this study. We are not asking for your name on the survey, and will only utilize information collected in summary form to categorize or further explain important differences. If we are able to deduce your identity, the research will be confidential. Confidential means that the research records will include some information about you and this information will be stored in such a manner that there is some linkage between your identity (as deduced but not specified) and the response in the research. The information collected about you includes your opinions about climate change risks, ratings of concern about climate change impacts and your assessment of the needs for various climate adaptation programs. Please note that we will keep this information confidential by not including your name in the data records, limiting individual access to the research data and keeping it in a secure location. The research team and the Institutional Review Board (a committee that reviews research studies in order to protect research participants) at Rutgers are the only parties that will be allowed to see the data, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated. All study data will be kept for three years. The benefits of completing the survey are that you will contribute to further knowledge and insight about impacts to New Jersey from climate change and help to inform the development and prioritization of resources needed to support new or expanded programs or policies to address these impacts. The survey should take about 10-15 minutes to complete. Participation is completely voluntary and refusal to participate will result in no penalties. You may opt out of completion of the survey at any time while taking it. If you have questions related to the research, please contact Jeanne Herb, Associate Director of the Environmental Analysis and Communication group, 33 Livingston Ave., New Brunswick, NJ 08901, 848-932-2725, jherb@ejb.rutgers.edu. If you have questions about your rights as a research subject, you may contact the IRB Administrator at Rutgers University at:

Human Subjects	Rutgers University Institutional Review Board for the Protection of Office of Research and Sponsored Programs	3
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Rutgers Plaza
0150

New Brunswick, NJ08901-8559
Email: humansubjects@orsp.rutgers.edu

Tel: 838 932

- I have read and understand the risks and benefits of this research and agree to participate by typing my initials in this box. _____

Q32 Note: Where the term “water utility” is used in this survey, it refers to both water supply and wastewater utilities. **GENERAL INFORMATION** Please indicate the organization that emailed you the link to this survey.

- American Water Works Association - NJ Chapter
- Association of Environmental Authorities
- NJ Water Environment Association

Q2 Please indicate the primary sector(s) in which you work:

- Public Community Water Supply System (publicly-owned)
- Public Non-Community or Non-Public Water Supply System (all ownership categories)
- Public/Domestic Wastewater Utility (publicly owned)
- Investor-owned Public Community Water Supply System
- Investor-owned Public/Domestic Wastewater Utility
- Other Private Sector (e.g. Industry) Water Supply/Wastewater
- Municipal Government
- County Government
- State Government
- Federal Government
- Consultant
- Contractor
- Equipment Manufacturer or Supplier
- Nonprofit
- Academic
- Other _____

Q3 In what aspects of water utility functions do you typically work? Select all that apply:

- Elected Official with water utility oversight and/or Non-Executive Water Utility Board Member
- Executive Management (CEO/COO or similar)
- Operations Management
- Treatment Operations
- Pipelines and Pumping Station Operations
- Administrative Support
- Rates / Regulatory Affairs
- Legal
- Engineering
- Planning
- Finance / Accounting
- Construction Management
- Public Policy / Government Affairs
- Emergency Preparedness
- Construction, Equipment Supply
- Other _____
- Not Applicable (don't work for or with water utilities)

Q26 What is your position?

- Non-Executive Board Member
- Elected Official with water utility oversight responsibilities
- Utility Executive Director/CEO/COO
- Utility Manager (other than Executive Director/CEO/COO)
- Utility Supervisor
- Utility Technical Staff
- Utility Non-technical Staff
- Consultant or Attorney (not on utility staff)
- Researcher and/or Academia
- Other _____

Q5 How long have you been in this position?

- 1 - 5 years
- 6 - 10 years
- 11 - 20 years
- More than 20 years

Q34 How long has your organization (or its predecessor) provided service in New Jersey?

- More than 100 years
- 50 - 100 years
- 25 - 50 years
- Less than 25 years

Q33 Primary type of community served by your Water Supply or Wastewater utility:

- Rural
- Suburban
- Urban
- Mixed (two or more of the above)
- Not Applicable (not associated with a water utility)

Q6 Do you live in New Jersey?

- Yes
- No

Q5 CLIMATE CHANGE AND WATER UTILITIES Do you Strongly Agree, Agree, Disagree or Strongly Disagree (or Don't Know) with the following statements?

	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know
Global climate change is not occurring.	•	•	•	•	•
Global climate change is mostly caused by human activity.	•	•	•	•	•
Global climate change is primarily a natural phenomenon that occurs cyclically.	•	•	•	•	•
Global climate change is a risk to New Jersey.	•	•	•	•	•
Global climate change is a risk to me, my family, and my friends.	•	•	•	•	•

<p>The international scientific community understands the science behind global climate change.</p>	•	•	•	•	•
<p>I trust the scientific community to truthfully report their findings related to climate change.</p>	•	•	•	•	•
<p>Our state and local officials understand the implications of global climate change for my service area.</p>	•	•	•	•	•
<p>Our state and local officials understand the implications of global climate change for my industry</p>	•	•	•	•	•

<p>sector.</p> <p>The media I rely on communicate honestly with us about global climate change.</p> <p>It is possible for public policymakers to develop adaptations to climate change to minimize adverse effects.</p> <p>It is possible for water and wastewater utilities to develop adaptations to climate change to minimize adverse effects.</p>	<p>•</p> <p>•</p> <p>•</p>				
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Q6 Please rate how concerned you are about the following potential direct and indirect climate change related impacts to the ability of your water utility (if you are associated with a water utility) in your service area or to water utilities in general (if you are not associated with a water utility) to provide service:

	Great Concern	Some Concern	Little Concern	No Concern	Not applicable
Higher average ambient air temperature	•	•	•	•	•
Increased algal blooms / eutrophication	•	•	•	•	•
Increased concentration of water pollutants	•	•	•	•	•
Reduced water flows in streams and lakes	•	•	•	•	•
Reduced recharge of aquifers	•	•	•	•	•
More severe droughts	•	•	•	•	•
Salt water intrusion	•	•	•	•	•
Increased annual water demand	•	•	•	•	•
Increased summer season water	•	•	•	•	•

demand					
Decreased annual water demand	•	•	•	•	•
Increased frequency of severe storms	•	•	•	•	•
Increased severity of storms	•	•	•	•	•
Increased stormwater flows	•	•	•	•	•
Increased occurrence / severity of coastal floods	•	•	•	•	•
Increased severity of coastal storm surges	•	•	•	•	•
Increased occurrence / severity of river floods	•	•	•	•	•
Increased inundation of low-lying infrastructure (roads, pumping stations, electrical utility)	•	•	•	•	•

substations, etc.)					
Release of toxic materials from flooding of hazardous or contaminated sites	•	•	•	•	•
Increased heat stress/stroke (for field workers)	•	•	•	•	•
Worker health and safety during major events	•	•	•	•	•
Increased sanitary sewer overflows (SSOs)	•	•	•	•	•
Increased combined sewer overflows (CSOs)	•	•	•	•	•
Increased infiltration and inflow (I&I)	•	•	•	•	•
Physical damage/ deterioration to critical	•	•	•	•	•

utility infrastructure (energy, water, wastewater)					
Decrease in effectiveness of water supply and sewage treatment systems	•	•	•	•	•
Increase in severity and length of unplanned service interruptions	•	•	•	•	•
Other	•	•	•	•	•

Q35 Please rate the preparedness of your organization:

	Not at all prepared	Somewhat prepared	Adequately prepared	Extremely well-prepared	Don't know
The preparedness of your organization for a major storm event prior to Hurricane Irene	•	•	•	•	•
The preparedness of your organization for a major storm event post Hurricane Sandy	•	•	•	•	•

Q36 ASSET MANAGEMENT FOR WATER UTILITIES USEPA and others have recommended that water utilities (water supply and wastewater) prepare and implement long-term asset management plans. Which choice below represents your opinion of the long-term sustainability of an asset management program for water utilities?

- Only a buzz word or temporary fad, unlikely to be a sustainable program
- Likely to be implemented voluntarily by most systems as a standard business practice
- Likely to be implemented ad hoc rather than system-wide within individual utilities
- Likely to be mandated through State funding requirements or regulations
- Don't know/No opinion

Q40 Which choice below best represents the current level of asset management implementation in the water utility which with you are most closely associated?

- None
- Minimal (some implementation regarding tracking and assessing assets)
- Partial (implemented some specific asset management tools for managing risk and reducing lifecycle costs, and are developing an asset management plan)
- Significant (developed an asset management plan and initiated substantive implementation)
- Full (fully implemented a long-term asset management plan)
- Don't Know/No opinion

Q42 Rate the value of asset management programs for water utilities:

	Adversely	Somewhat Adversely	Neutral	Somewhat Beneficial	Dramatically Beneficial	Don't know
Improve internal coordination, communications and operation of the utility	•	•	•	•	•	•
Assist with knowledge retention and information transfer within the utility	•	•	•	•	•	•
Prolong asset life and value	•	•	•	•	•	•
Assist with managing risk	•	•	•	•	•	•
Improve regulatory compliance	•	•	•	•	•	•

Improve security and safety of assets, employees and the general public	•	•	•	•	•	•
Reduce disruptions to service and protect against business risk exposure	•	•	•	•	•	•
Assist with decision making approaches for capital improvements	•	•	•	•	•	•
Reduce operating and maintenance costs	•	•	•	•	•	•
Reduce long-term capital expenditures	•	•	•	•	•	•
Assist with public confidence and developing justifiable rates	•	•	•	•	•	•
Improve the utility's bond rating and lower interest rates	•	•	•	•	•	•
Lower utility insurance	•	•	•	•	•	•

premiums						
Improve rankings for funding for grants and low interest loans	•	•	•	•	•	•

Q46 Which, if any, of the following measures has your organization employed that reduce its contribution to greenhouse gas emissions:

- Installation of solar or wind energy systems
- Energy conservation measures
- Water conservation measures
- Fuel switching (e.g., oil or propane to natural gas)
- Building modifications for energy efficiency
- Use of electric fleet vehicles
- Use of natural gas/CNG powered fleet vehicles
- Water leak measurement and prevention
- Offering of customer-oriented conservation measures
- None
- Don't know

Q49 Click the arrow below to submit. Thank you for taking this survey!

Appendix D: Responses to Water Utilities Survey Regarding Climate Change Impacts

Question: Please rate how concerned you are about the following potential direct and indirect climate change related impacts to the ability of your water utility (if you are associated with a water utility) in your service area or to water utilities in general (if you are not associated with a water utility) to provide service:	Great Concern	Some Concern	Little Concern	No Concern	Total Responses	Mean	Ratio Great to Some Concern
Increased severity of storms	45	34	7	5	91	1.69	1.32
Increased severity of coastal storm surges	36	28	12	8	84	1.90	1.29
Physical damage/ deterioration to critical utility infrastructure (energy, water, wastewater)	41	37	9	4	91	1.74	1.11
Increased occurrence / severity of coastal floods	35	32	11	8	86	1.91	1.09
Increased frequency of severe storms	40	37	9	5	91	1.77	1.08
More severe droughts	40	38	8	5	91	1.76	1.05
Increased infiltration and inflow (I&I)	32	32	18	7	89	2.00	1.00
Increased inundation of low-lying infrastructure (roads, pumping stations, electrical utility substations, etc.)	38	40	7	4	89	1.74	0.95
Increased sanitary sewer overflows (SSOs)	32	36	13	8	89	1.97	0.89
Increased combined sewer overflows (CSOs)	26	31	12	9	78	2.05	0.84
Reduced water flows in streams and lakes	30	39	12	5	86	1.91	0.77
Reduced recharge of aquifers	33	43	7	5	88	1.82	0.77
Increased stormwater flows	31	41	12	6	90	1.92	0.76
Release of toxic materials from flooding of hazardous or contaminated sites	27	36	20	6	89	2.06	0.75
Worker health and safety during major events	29	40	14	6	89	1.97	0.73
Increased summer season water demand	28	40	14	7	89	2.00	0.70
Increased occurrence / severity of river floods	30	43	10	7	90	1.93	0.70

Question: Please rate how concerned you are about the following potential direct and indirect climate change related impacts to the ability of your water utility (if you are associated with a water utility) in your service area or to water utilities in general (if you are not associated with a water utility) to provide service:	Great Concern	Some Concern	Little Concern	No Concern	Total Responses	Mean	Ratio Great to Some Concern
Increase in severity and length of unplanned service interruptions	31	45	10	4	90	1.86	0.69
Decrease in effectiveness of water supply and sewage treatment systems	28	41	14	8	91	2.02	0.68
Increased concentration of water pollutants	26	42	16	6	90	2.02	0.62
Increased annual water demand	23	40	20	7	90	2.12	0.58
Decreased annual water demand	13	26	27	23	89	2.67	0.50
Salt water intrusion	19	39	17	12	87	2.25	0.49
Increased algal blooms / eutrophication	18	47	12	9	86	2.14	0.38
Increased heat stress/stroke (for field workers)	13	34	33	9	89	2.43	0.38
Higher average ambient air temperature	9	47	21	12	89	2.40	0.19
Other (Municipalities and Counties raiding capital reserves and funds of Utilities Authorities to balance their budget to the detriment of the utility) (Misinformation) (Economic and humanitarian consequences of disruptions elsewhere, including in other countries)	3	1	0	1	5		

Appendix E: Responses to Water Utilities Survey Regarding Critical Actions

Question: What are the most important actions/programs needed at the regional, statewide or national level (both governmental and non-governmental) to support water utility efforts to prepare and respond to climate change impacts?	Very Important	Important	Somewhat Important	Total Responses	Mean	Ratio Very Important to
Resilient emergency communications infrastructure	32	10	4	46	1.39	3.20
Regulatory programs to encourage the accelerated replacement of aging infrastructure	25	9	10	44	1.66	2.78
Clearly established emergency response lines of communication	30	13	3	46	1.41	2.31
Clear policy direction with supporting incentives to expedite hardening and resiliency measures	23	17	4	44	1.57	1.35
Critical infrastructure assessments	23	18	5	46	1.61	1.28
Updated regulations or guidelines addressing design and construction standards	14	11	6	31	1.74	1.27
Rapid response system for extreme weather events	19	15	11	45	1.82	1.27
Development of innovative funding strategies to implement adaptation measures	21	17	4	42	1.60	1.24
Updated or new regulations addressing infrastructure upgrades	14	13	11	38	1.92	1.08
Improved planning, coordination, and communication across affected entities	22	22	3	47	1.60	1.00
Updated or new regulations addressing floodplain construction	12	13	12	37	2.00	0.92
Incentive programs to relocate development away from vulnerable areas	13	15	7	35	1.83	0.87
Inland waterways flood hazard delineation data and projections	13	15	14	42	2.02	0.87
Updated or new regulations addressing floodplain delineation revision	12	14	13	39	2.03	0.86

Question: What are the most important actions/programs needed at the regional, statewide or national level (both governmental and non-governmental) to support water utility efforts to prepare and respond to climate change impacts?	Very Important	Important	Somewhat Important	Total Responses	Mean	Ratio Very Important to Important
Improved coordination between water utilities and other sectors (health, planning, transportation, emergency planning)	17	20	8	45	1.80	0.85
Strengthened employee training and retention for water utilities	17	20	8	45	1.80	0.85
Shoreline change data and projections	11	13	11	35	2.00	0.85
Updated or new regulations addressing emergency planning	11	13	13	37	2.05	0.85
Strengthened training of governing bodies for water utilities	15	19	8	42	1.83	0.79
Updated or new regulations addressing hazard mitigation planning	11	14	12	37	2.03	0.79
Improved coordination between water utilities (mutual aid) and state resources	17	23	5	45	1.73	0.74
Assistance with stockpiling of supplies	11	18	12	41	2.02	0.61
Improved climate and weather modeling capacity for local scale assessments (long-term)	9	19	13	41	2.10	0.47
Enhanced weather forecasting (short-term)	11	25	8	44	1.93	0.44
Water supply planning and conservation	10	23	9	42	1.98	0.43
Socioeconomic vulnerability assessments	5	15	13	33	2.24	0.33

Appendix F: Questionnaire and Responses from Environmental Summit

August 20, 2013

1. Do you strongly agree, agree, disagree, or strongly disagree with the following statements? (14 responses)

	Strongly Agree	Agree	Disagree	Strongly Disagree	D/K, N/R
Global climate change is not occurring	0	0	0	14	0
Global climate change is mostly caused by human activity	11	3	0	0	0
Global climate change is primarily a natural phenomenon that occurs cyclically	0	2	8	3	0
Global climate change is a risk to New Jersey	12	2	0	0	0
Global climate change is a risk to me, my family, and my friends	11	3	0	0	0
The international scientific community understands the science behind global climate change	9	5	0	0	0
I trust the scientific community to truthfully report their findings related to climate change	7	6	1	0	0
Our state and local officials understand the implications of global climate change for my service area	0	0	8	6	0
Our state and local officials understand the implications of global climate change	0	0	8	6	0
The media I rely on communicate honestly with us about global climate change	0	3	5	4	2
It is possible for public policymakers to develop adaptations to climate change to minimize adverse effects	5	7	1	0	1
It is possible for society to develop adaptations to climate change to minimize adverse effects	6	6	1	0	1

2. Please rate how concerned you are about the following potential direct and indirect climate-change related impacts to water resources and water utilities: (14 responses)

	Great Concern	Some Concern	Little Concern	No Concern	N/A N/R
Higher average ambient air temperatures	7	4	3	0	0
Higher water temperature	11	3	0	0	0
Increased algal blooms/eutrophication	8	5	0	0	1
Increased concentration of water pollutants	8	5	1	0	0
Reduced water flows in streams and lakes	6	6	0	0	2
Reduced recharge of aquifers	11	3	0	0	0
Reduced water supply availability	10	4	0	0	0
More severe droughts	9	4	1	0	0
Salinity changes in water resources	6	8	0	0	0
Increased annual water demand	6	5	2	1	0
Increased summer season water demand	7	4	3	0	0
Decreased annual water demand	0	3	3	7	1
Increased frequency of severe storms	9	5	0	0	0
Increased severity of storms	10	4	0	0	0
Unpredictability of weather patterns	6	7	1	0	0
Increased stormwater flows	7	7	0	0	0
Increased occurrence/severity of coastal floods	9	5	0	0	0
Increased coastal erosion	9	4	1	0	0
Increased severity of coastal storm surges	12	2	0	0	0
Increased tidal wetland erosion/loss	10	3	1	0	0
Increased occurrence/severity of non-tidal river floods	7	6	1	0	0
Reduced flood attenuation	4	6	3	1	0
Increased inundation of low-lying infrastructure (roads, substations, etc.)	5	7	1	0	1

	Great Concern	Some Concern	Little Concern	No Concern	N/A N/R
Release of toxic materials from flooding of hazardous or contaminated sites	10	4	0	0	0
Increased spread of invasive species	5	6	3	0	0
Increased heat stress/stroke (for field workers)	3	7	4	0	0
Worker health and safety during major events	5	7	2	0	0
Public health and safety during major events	8	5	1	0	0
Increased sanitary sewer overflows (SSOs)	10	3	1	0	0
Increased combined sewer overflows (CSOs)	10	3	1	0	0
Increased Infiltration and Inflow (I&I)	6	6	1	0	1
Physical damage to critical utility infrastructure (energy, water, wastewater)	10	2	1	0	0
Decrease in effectiveness of water supply and sewage treatment systems	9	3	1	0	1
Loss of assets due to permanent damage	2	7	5	0	0
Increase in severity and length of unplanned service interruptions	5	5	4	0	0
Difficulty with contingency planning due to lack of experience	5	4	4	1	0
Other: Lack of Federal/State Coordination	1				
Other: _____					

3. Of the following climate change adaptations, which are mostly in place, planned or needed in New Jersey? (14 responses)

	Mostly In Place	Anticipated or Planned	Not Planned but Needed	Not Needed Generally	D/K, N/A, N/R
Local climate adaptation plans	0	2	12	0	0
Hazard mitigation plans	1	5	7	0	1
Vulnerability assessments/Census of vulnerable sub-populations	1	3	9	0	1
Emergency preparedness plans that incorporate climate changes and local capacities	1	7	6	0	0
Risk maps (e.g., inundation)	3	6	4	0	1
Alternate service distribution routes (e.g., interconnections)	1	5	5	0	3
Public and employee awareness campaign on emergency preparedness	3	4	7	0	0
Inclusion of vulnerable populations in emergency preparedness plans	1	4	9	0	0
Heat warning system	3	1	6	0	3
Local electric utility communication plan for outages	2	7	4	0	1
Local water utility communication plan for outages	1	4	8	0	1
Crisis and Emergency Response Risk Communication System	4	4	5	0	1
Public awareness program on climate change impacts	0	1	12	0	1
Stockpiling of supplies (fuel, food, water, medicine)	0	4	6	1	2
Green infrastructure (e.g. riparian buffers, living shorelines, native landscaping,	0	3	11	0	0

	Mostly In Place	Anticipated or Planned	Not Planned but Needed	Not Needed Generally	D/K, N/A, N/R
tree planting, wetland restoration, porous pavement, etc.)					
Capital improvement and maintenance plans which incorporate climate change	0	1	12	0	1
Buyout of properties in high hazard floodplains	1	8	5	0	0
Raising, relocating or flood-proofing capital facilities prone to flooding or storm surges	0	7	7	0	0
Other: Support Regional Planning			1		

4. What are the most important actions/programs needed at the regional, statewide or national level (both governmental and non-governmental) to support efforts to prepare and respond to climate change impacts? (13 responses)

	Very Important	Important	Somewhat Important	Not Important	D/K N/R
Incentive programs to relocate development away from vulnerable areas	8	3	1	1	0
Socioeconomic vulnerability assessments	5	6	1	0	1
Regulatory programs to encourage the accelerated replacement of aging infrastructure	4	7	2	0	0
Clear policy direction with supporting incentives to expedite hardening and resiliency measures	7	4	1	1	0
Clearly established emergency response lines of communication	5	7	1	0	0

	Very Important	Important	Somewhat Important	Not Important	D/K N/R
Improved planning, coordination and communication across affected entities	9	4	0	0	0
Enhanced weather forecasting	1	6	5	1	0
Improved climate and weather modeling capacity for local scale assessments	1	5	5	2	0
Critical infrastructure assessments	6	6	1	0	0
Improved coordination between water utilities (mutual aid) and state resources	8	3	2	0	0
Improved coordination between water utilities and other sectors (health, planning, transportation, emergency planning)	8	4	1	0	0
Strengthened employee training and retention for water utilities	2	8	3	0	0
Rapid response system for extreme weather events	8	5	0	0	0
Strengthened training of governing bodies for water utilities	4	5	4	0	0
Training of local government officials as to the constraints affecting restoration	9	3	1	0	0
Resilient emergency communications infrastructure	4	7	1	0	1
Enhanced GIS and LiDAR data	1	10	1	0	1
Development of innovative funding strategies to implement adaptation measures	7	4	2	0	0
Water supply planning and conservation programs	11	2	0	0	0

	Very Important	Important	Somewhat Important	Not Important	D/K N/R
Updated regulations or guidelines addressing design and construction standards	8	4	0	0	1
Shoreline change data and projections	9	4	0	0	0
Inland waterways flood hazard are delineation data and projections	8	3	2	0	0
Assistance with stockpiling of supplies	1	2	9	0	1
Updated or new regulations:					
Emergency planning	4	5	3	0	1
Infrastructure upgrades	9	4	0	0	0
Floodplain delineation revision	9	4	0	0	0
Floodplain construction	7	4	0	0	2
Hazard mitigation planning	9	4	0	0	0
Other: Sea level rise policies	1				

Appendix E: Environmental Summit Oral Responses (20 August 2013)

1. What climate change impacts do you consider more critical to New Jersey than those associated with water resources and water utilities?

- Ecosystem/species losses and shifts may be of equal importance
- Sea level rise regarding physical impacts on land development
- Extreme temperatures regarding morbidity/mortality, especially in cities
- Extreme temperatures regarding agricultural viability
- Economic impacts of adaptation, including the costs of migration from hazardous areas and responses to climate change impacts
- Transportation system viability

2. What climate change adaptation needs are most critical to New Jersey regarding impacts associated with water resources and water utilities?

- Responses to impacts of sea level rise
- Risk analysis of climate change impacts on land areas (flooding, storm surge, etc.) and the avoidance, modification or removal of development and water infrastructure in those areas
- Agriculture methods that improve viability in the face of extreme weather conditions and swings between extremes
- Protection of water supply source areas (including watersheds and recharge areas) and delivery systems
- Public education regarding the realities of water resource systems and climate change impacts
- Improvement of wastewater and stormwater systems, including regulatory program changes
- Political will to acknowledge and address issues of climate change
- Restoration of past damages (streams, etc.) to improve future resiliency
- Urban flood damage mitigation
- Conservation of water supplies including stream flows, recharge, water supply system losses and consumer uses

3. For what climate change adaptation needs associated with water resources and water utilities is New Jersey most behind where it needs to be?

- Sewerage and stormwater system protection and management regarding storm impacts
- Water supply and wastewater utilities are overwhelmed
- Public notification and education regarding impacts such as storm discharges from CSOs, stormwater systems and WWTPs
- Saltwater intrusion related to sea level rise (should be addressed in the NJ Statewide Water Supply Plan)
- Changing public behavior to adapt to climate change (versus assuming that the climate change impacts will be overcome without need for behavioral changes)
- Stormwater management shift to green infrastructure, in both development and redevelopment
- Civil engineers education and modernization of practice regarding climate change

Appendix G: Water Supply Advisory Council Oral Responses

August 16, 2013

1. What potential impacts of climate change are of greatest concern for water resources and water utilities?

- Uncertainties regarding rainfall patterns and amounts
- More precipitation extremes and impacts on utility operations
- Financing of changing operations in response to weather extremes
- Lengthening of growing season and effects on irrigation needs, ET
- Stress on regional resiliency
- Increased flooding of facilities
- Availability of utility power and backup
- Major storms restrict O&M activities
- Invasive species in water bodies
- High temperature effects on equipment
- Greater need for technical competence in utility staff as operations get complicated
- More intense storms will create more turbidity, increasing treatment costs and feasibility
- Sea level rise will create flooding, saltwater intrusion and wellhead flooding
- Water quality changes (chemical and biological) due to temperature increases
- Chemical needs for treatment due to temperature increases and biological impacts
- Potential ground water recharge losses that reduce aquifer yields/availability

2. What actions or programs are most needed in New Jersey to respond to climate change impacts regarding water resources and water utilities?

- The new NJ Statewide Water Supply plan is needed and should be released
- Improved technical training, both scholastic and utility staff. Raritan Valley Community College is starting a program for training beyond basic licensing needs.
- University “extension agent” approach for service to utilities
- Need university research faculty to focus on water utilities, resiliency and asset management. Rutgers used to have a core of faculty in the Department of Environmental Sciences, but many have retired over the years and not been replaced.
- Masters in Environmental Engineering – related to point above – significant interest
- Guidance and funding for incorporating resiliency in water utility functions
- Public education to create support for action
- Consistent set of climate change and precipitation scenarios, shared among and sanctioned by all relevant agencies, to serve as a basis for planning and design (similar to NJDEP use of design storms for stormwater management)
- Improved monitoring and data directly related to facilities and resources at risk

Appendix H: Discussion Notes: State and Regional Planning Organizations

Representatives of New Jersey Future, PlanSmartNJ and Regional Plan Association

1. Of the potential impacts of climate change affecting New Jersey, which are of greater importance than water resources (not including sea level rise)?
 - RPA conducted a public opinion poll this spring about greatest concerns. Electricity outages came out highest in concern.
 - Linked to maintaining an ability to communicate
 - Ability to get around – open streets, etc.
 - Distinctions need to be made between acute impacts (events) and chronic impacts (trends)
2. What water resources impacts will be most important to New Jersey?
 - Serious events that cause flooding, with attendant issues for drinking water systems, water quality impacts
 - Water Supply – will sea level rise create a significant problem for saltwater intrusion? Drought impacts are also a concern. What alternatives exist?
 - Infrastructure stress – both acute and chronic (long-term issue)
3. What aspects of climate change adaptation for water resources impacts are best addressed for the most part or entirely at the state or multi-state regional level?
 - State – vulnerability analysis, risk assessment and risk communication re SLR
 - State – NJSWSP that incorporates climate change impacts
 - State – review of and context for local decisions about land use, protection projects, etc.
 - State/Regional – interbasin water transfers, water storage support, release flow requirements
 - State – requirements for infrastructure asset management
 - Federal/State – Base Flood Elevations and FIRMs with realistic standards including SLR, recent decades of river flooding, climate change impacts
 - Federal/State – standards for flood zone construction.
 - State – framework for development and redevelopment priorities, open space investments. Tied to this should be financial/investment/taxation structure to make appropriate redevelopment feasible. Economic Development Authority, etc.
 - Federal/State – recover financing, technical expertise and standards
 - Federal/State – protection projects at larger scales, including design and coordination
 - State – stormwater standards, SWQS, GWQS
 - State – NJPDES and SDWA permit programs – require an expertise that locals don't have
 - State/Regional – Water allocations
4. Of the responses to #3, for which are we most advanced toward implementation? Why?
 - Blue Acres/Green Acres programs have a good framework and success rate. Funding needed.
 - Pinelands, Meadowlands and Highlands programs

- NJPDES MS4 permits and NJDEP development regulations are mature programs but need modifications to address the new issues
 - US Army Corps project capabilities
 - Governor's veto of the bill that would have authorized new residential development on piers
 - Utility focus on asset risks – some are, some aren't.
 - Sandy project funding – may be too early to tell. NJ must spend the funds quickly. NY has a great planning framework, which NJ does not – given the time constraints it will be hard to develop one now. Hard to know whether the NY approach will work. Elevation of homes at risk is good, as is the Blue Acres work.
5. Of the responses to #3, for which are we least advanced toward implementation, or actually regressing? Why?
- State – Acknowledging SLR and incorporating it in policies. May be a problem due to local cost implications, political ideology, anti-FEMA groups.
 - State – Funding for Green Acres/Blue Acres (outside of Sandy response for Blue Acres)
 - State – Lack of a State Plan and NJSWSP
 - Federal/State – infrastructure funding for transportation and water
 - State - NJPDES permit enforcement a question mark
 - State – Incorporation of SLR and other climate change risks into CAFRA/CZM program
 - State – Hazard Mitigation Planning efforts to limited, perfunctory
 - State – Lack of planning capacity generally
 - Why? Insufficient comprehension, professional competence, funding. Short-term thinking, and then short-term memories – what was critical becomes forgotten. People deny possible future risks (“It won't happen again/to me”). Planning isn't sexy – requires people to look into the future, which is difficult and not normal human behavior. There may be a feeling that we can't afford it, or that the necessary changes are anti-business. But electric utilities are investing a lot – have a pricing signal that works toward action.
6. What organizations or agencies are doing the best work in clarifying the critical water resources issues, advancing policy, and achieving implementation at the state or regional level?
- New Jersey Future, PlanSmartNJ and RPA all have strong emphases in this area. Pushing hard on land use policy, which affects water resources.
 - NYC as the regional example of forward planning. PlaNYC, SIRR approaches.
 - NY/NJ BayKeeper – keeping PVSC and CSO issues in the forefront
 - Delaware Riverkeeper
 - Facing Our Future – recent infrastructure report
 - NJ Association of Flood Plain Managers – doing good work on emphasizing those issues
 - USGS – ground water issues, general water resources research in the climate change area
 - Some media – NY Times, Newsworks

7. What organizations or agencies are blocking progress toward clarifying the critical water resources issues, advancing policy, and achieving implementation at the state or regional level?
 - The Governor – pulled out of RGGI, etc. Impossible to get word as to possible initiatives, no public process for setting the vision
 - Tea Party types
 - National security issue make it hard to conduct a public vulnerability analysis/risk assessment
 - Real estate/development interests seem fine with addressing infrastructure needs, but don't like development restrictions
 - DCA Site Improvement Advisory Board – are the RSIS blocking use of green infrastructure, better road designs, Complete Streets? May need to update RSIS. Has anyone raised the point to them?
8. What most stands in the way of progress?
 - Insufficient risk awareness and willingness to invest in the future. Hard to see what is needed.
 - Political leadership to mold public opinion.
 - What would create the necessary groundswell of public interest in action?
 - The lack of funding is linked to the lack of leadership which is linked to short-sightedness
 - Lack of sustained interests leads to episodic funding, which is less efficient and effective
 - Lack of a coherent vision, and coherence in communication about the issue
 - State campaign is focused on “Stronger the Storm” rather than developing a consensus vision of a better future. Overcoming Sandy, rather than responding to broader issues.